Population Epidemiology

An Emerging Field of Inquiry for Population and Health Students

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The application of epidemiological principles and techniques to the fields of population dynamics and family planning program development has given rise to the field of inquiry termed "population epidemiology." The scope of this new area of study is described.

Introduction

The perspectives and principles of epidemiology can be fruitfully applied far beyond the discipline's traditional realm of the study of outbreaks of acute communicable diseases. Epidemiological methods have been extended to studies of the determinants and consequences of chronic diseases and accidents, to studies of growth and development, pregnancy outcome, and prematurity, and now also to studies of health-relevant behavior and the working of health service systems. In addition to making use of basic epidemiological research approaches, the exploration of each of these newer areas has called for further elaboration of methodology, for a critical review and expansion of existing hypotheses, and for the preparation of investigators who are equipped to develop and apply such methods to new fields of study.

Recent experience in population dynamics and family planning programs has shown that this is a field to which epidemiological principles can profitably be applied and which calls for a considerable expansion of research strategy. Epidemiology's potentially great contribution to the population field was not recognized until recently for three main reasons: First, since its inception epidemiology has been identified with a special field of inquiry, namely mass disease distribution and control. Second, the field of population has been overwhelmingly identified with other disciplines, especially demography, sociology, and economics. And third, this identification of population with other disciplines occurred when epidemiologists were so preoccupied with many other worthy interests that their contribution to the new field has been relatively recent and mainly tangential.[1] The role of epidemiology in the field of population and family planning is therefore yet to be precisely determined and systematically characterized.

Over the past several years, this author has been exploring the possibilities for epidemiological contribution to population studies with three main objectives:

- To develop new epidemiological research approaches to the field of population dynamics and family planning program development;
- To structure a body of knowledge concerning the epidemiological aspects of various population phenomena and of program operation; and
- To expand the existing network of hypotheses on the determinants, process, and consequences of population change.

The purpose of this paper is to outline briefly the rationale and scope of the field of inquiry which has been called "population epidemiology." I should hasten to add that this is not a new brand of epidemiology; it is rather a new field for the application of epidemiological principles

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and methods. Although these principles and methods are the same whether they are applied to communicable disease, to cardiovascular disease, to radiation, or to any other matter for investigation, every new field of application acquires its own body of knowledge, its own jargon, and its own methodological breakthroughs. Thus, the use of the term "population epidemiology" here is a demarcation of an emerging field of inquiry for epidemiologists. Because of space limitation, the dimensions of the field will be outlined with no extensive discussion or documentation.

Why Population Epidemiology?

A question that has been asked by nonepidemiologists and even by some epidemiologists is this: Why should epidemiology extend its frontiers to the very broad field of population and family planning? The answer is simple. The successful use of epidemiology in understanding and combatting disease and supporting health programs indicates its potential utility in research on population dynamics and family planning programs for the following reasons:

1. The population problem is a mass phenomenon subject to epidemiological inquiry in much the same way as other mass phenomena such as epidemics. The etymological derivation of the word "epidemiology" suggests its purview: epi = upon, demos = people, logos = study, that is, the study of what "comes upon" people. This derivation gives epidemiology a seemingly stronger emphasis with regard to population change and population phenomena than even demography (demos = people, graphy = description). Thus, demography may be concerned mainly with the description of population phenomena and movement, but epidemiology goes beyond description to a rigorous analysis of these phenomena along with their determinants and consequences. As Wade Hampton Frost has put it:

> Epidemiology at any given time is something more than the total of its established facts. It includes their orderly arrangement into chains of inference which extend more or less beyond the bounds of direct observation. Such of these chains as are well and truly laid guide investigation to the facts of the future; those that are ill made fetter progress. But it is not easy, when divergent theories are presented, to distinguish immediately between those which are sound and those which are merely plausible. Therefore it is instructive to turn back to arguments which have been tested by the subsequent course of events; to cultivate discrimination by the study of those which the advance of definite knowledge has confirmed.[2]

This discussion is not meant to belittle demography in any way but rather to emphasize the complementary role of epidemiology in the study of population phenomena. It is an attempt to show how the talents and experience of epidemiologists can join the efforts of demographers and other social scientists in the study of one of the most intractable problems ever to face the human race. Kurt Mayer, a social scientist, has suggested that multidisciplinary involvement in population studies is indeed necessary:

> Any meaningful interpretation of the causes and effects of population changes must . . . extend beyond formal statistical measurement of the components of change, and draw on the theoretical framework of several other disciplines for assistance.[3]

2. Even if epidemiology is conservatively restricted to its traditional realm, namely health, there can be no doubt that health is a key variable in population dynamics and family planning programs. First, morbidity and mortality are variables which may affect and be affected by fertility. For example, child morbidity and mortality rates may determine in part whether or not couples are willing to practice fertility control. A woman's fertility may significantly affect her health and the health of other family members.

Second, various population phenomena may be considered as health phenomena as well. "Excess" fertility may for illustrative purposes be considered to be a social ill of mankind amenable to traditional methods of epidemiological inquiry and description. Excess fertility may be shown to have a pattern of occurrence and distribution, an "attack" or prevalence rate in population groups, and a historical trend with endemic and epidemic fluctuations. In a description of the factors associated with excess fertility, epidemiologists can formulate hypotheses on causal relationships and test these hypotheses to determine relative and attributable risks and to characterize high risk groups. In these tasks, the basic strategy of epidemiology can be applied in order to compare those individuals or groups who have and those who do not have excess fertility; a comparison of the degree of excess related to each of the suspected causal factors can be used to develop risk formulas or models. Epidemiologists can also help to develop methods of identifying cases (case finding), then prescribe and evaluate preventive measures (for example, contraception, sterilization, age at marriage) or curative measures (such as abortion) based on a knowledge of which links in the chain of causation are most amenable to intervention.

3. Epidemiology has always been a master science in the study of causation and association, hence its great value in the study of population change which encompasses a complex matrix of interactions and associations. Not only are the determinants and consequences of population change within the domain of epidemiology, but it can be argued that it is appropriate to describe the whole process of population change, the so-called transition, in epidemiological rather than just demographic terms.

4. Epidemiologists have always been concerned with the working of health services and the evaluation of health programs and can, in similar fashion, evaluate the working of family planning programs and program acceptance.

5. Epidemiology can contribute to the field of population an impressive reservoir of knowledge about a

host of mass phenomena not restricted to disease, as well as historically tested methods of research.

The Scope and Uses of Population Epidemiology

It may now be appropriate to delineate some of the specific areas in which epidemiological principles and methods can be applied to the field of population and family planning. The following uses of epidemiology are not mutually exclusive nor are these functions the exclusive province of epidemiologists; they are—and should be—shared by students of other disciplines.

1. Community Diagnosis in Population

A traditional function of epidemiology that can be used to advantage in the population field is community diagnosis. Epidemiologists, alone or in collaboration with colleagues from other disciplines, can provide, perfect, and validate indices and measurements of population pressures at the national, subnational, or family levels, including pressures on the social, economic, and health systems, and on education and manpower development. Reproductive risks can be assessed and high risk groups identified. Epidemiologists can also provide data and insights for better prediction of future trends. Population projections should no more be limited to mathematical calculation of future trends but should be built on careful epidemiological assessment of possible changes in morbidity, mortality, and fertility dynamics and the prospects of health and family planning program successes and limitations.

2. Community Health and Population Change

The traditional function of epidemiology is to clarify the relationships between health and other factors in a total community situation. There is an increasing need to assess more accurately the significance and extent of relationships between population change and various dimensions of health and health-relevant behavior. These relationships include, for example, health aspects of crowding, the effects of changing age and sex composition of the population on patterns of disease and on health programs and the equally important effects of changing patterns of health and disease on population profiles. When, for example, pandemics of infectious diseases and famine started to recede in western countries, children benefited the most and childhood survival improved significantly, resulting in an increase in the young sectors of the population. At the same time, improvements in fertility performance (perhaps because of increased life expectancy, decreased widowhood, improved maternal health, etc.) were manifested in a definite increase in the birth rate. Under such circumstances, there occurs a wave of larger numbers of infants being born, surviving childhood, and moving up through the population pyramid.

Somehow the dynamics of health and population change also favor the female to such an extent that women commonly switch from a mortality level higher than that of men to a level more advantageous than that of men as overall death rates decline.

3. Epidemiology and Population Theory

Efforts to broaden the traditional concepts of the demographic transition through epidemiological analysis have led to the development of the theory of epidemiological transition in an attempt to provide insights into population phenomena so far inadequately explained.[4] It is hoped that the theory of epidemiological transition will enhance the accuracy of population projections and foster the development of adequate population policies.

The theory of epidemiological transition focuses on the complex changes in patterns of health and disease over time and on the interactions between these patterns and their demographic, economic, and sociological determinants. Its structure was developed through research in historical demography, economics, and epidemiology. There can be little doubt that an epidemiological transition accompanied the demographic and economic transitions in the now developed countries of the world and that such a transition is still underway in less developed societies.

Changes in patterns of disease and death can be characterized by distinct phases from the Age of Pestilence and Famine through the early and late phases of the Age of Receding Pandemics to the Age of Degenerative and Man-Made Diseases. The devastating famines and epidemics of specific diseases as well as endemic infection and chronic malnutrition recede while a gradual increase in diseases of a degenerative and man-made nature, such as cardiovascular diseases and cancer, takes place. The recession in infections and undernutrition—health problems which contribute to early death—has a great effect on overall mortality, which declines drastically with corresponding increases in life expectancy.

Two major eras are relevant to the theory of epidemiological transition. The first is the premodern era when only cyclic changes in population growth occurred; the second is the modern era, beginning about the middle of the 17th century, in which profound changes have occurred in various countries at different rates. Depending on the pace and particulars of the change, three transitional models can be distinguished. The classical model characterizes most western developed countries such as England and Wales, in which the transition took place comparatively slowly over a period of two or more centuries largely in response to social change. Mortality declined first, followed after a time lag by fertility. The accelerated model fits countries such as Japan and this model, too, is largely socially dependent. In the delayed or contemporary model, which is the model closest to the experience of the recently developed and now developing countries of the world, the mortality transition is rapid, taking only a few decades rather than centuries, and it is largely the result of medical rather than social advances. The natality transition is, on

the other hand, much slower and occurs after a considerable time lag.

4. Reproductive Epidemiology and Assessment of Reproductive Risks

The area of reproductive epidemiology includes studies of the physiological variables affecting human reproduction, such as lactation practices, diseases affecting fecundity, population genetics, maternal age, parental health, menarche, menopause, and cycles of sexual behavior. It also includes studies of the epidemiology of pregnancy outcome, of abortion and its influences on population change, the determinants and consequences of perinatal and childhood mortality, the relationships of family size, maternal age, and birth interval to health and disease in family members, and the roles of fetal wastage and infant mortality in determining family size and fertility limitation. Two examples from this field of endeavor are given below:

a. Developing the health theme in family planning. A monograph and several papers and lectures have grown out of an interest in the interactions between health and family planning—at both the individual and national levels.[5,6] An extensive literature review presented in the monograph gives evidence of two kinds of interactions:

(1) The unplanned family—that is, one in which there are many children, closely spaced, born at too young or too old maternal ages—is more likely than the smaller, planned family to suffer from infant mortality, maternal morbidity and mortality, ill health among family members, and slower growth and development of children, both physically and intellectually.

(2) Childhood mortality seems to influence fertility patterns in that families with experience of or expectation of frequent child deaths will not practice family planning for fear that they will be left without surviving children.

Thus it is suggested that family planning programs and health programs should work together, that good family health can be one motivation (and one that is highly acceptable in nearly every culture) for practicing family planning, and that health programs aimed at reducing infant and childhood mortality can increase the willingness of parents to practice birth control. The health rationale in family planning can also be used to convince and recruit the support of the medical profession, so that advice on family planning will form an integral part of everyday health practice, recalling a long forgotten statement made by Dr. Charles Knowlton in the 1830s:

> . . . it is as much the duty of the physician to inform mankind of the means of preventing the evils that are liable to arise from gratifying the reproductive instinct, as it is to inform them how to keep clear of the gout or the dyspepsia.[7]

It is also appropriate that family planning be redefined in a broader context to include planning not only the number but also the timing (in regard to mother's age) and interval between pregnancies in such a way as to foster optimum health for all family members. Family planning should also include treatment of involuntary infertility and prevention of unwanted pregnancies.

The health theme in family planning serves as a background to an international investigation of the problems of family building and family health and of childhood mortality and reproductive patterns in studies in Colombia, India, Pakistan, Iran, Lebanon, Turkey, Egypt, the Philippines, and Syria. These studies are sponsored by the World Health Organization and coordinated by the author.

b. The epidemiology of abortion and its role in the natality transition. Abortion has been a persistent endemic phenomenon; in modern times, according to the ever-accumulating epidemiological and sociological literature, abortion has been increasing in many areas of the world and has reached or threatens to reach epidemic proportions in a number of these areas. The factors influencing the level of abortion vary from one country to another and may depend on, among other things, the stage of the demographic or epidemiological transition through which the particular country is passing and on the state of abortion laws and the attitudes of the public and medical profession toward abortion. The incidence of abortion may also depend on specific population policies that may encourage or discourage induced abortion as a method of fertility control, on the tempo of family building, etc.

Epidemiological study seeks to characterize the natural history of abortion in population groups and to identify its determinants, its health, social and demographic consequences, high risk groups, its relationship to patterns of human reproduction, maternal health and other family characteristics, family building variables, societal and individual aspirations and value systems, and medical attitudes and population policies which may deliberately encourage or discourage induced abortion as a method of fertility control.[8]

Two significant questions necessitating rigorous epidemiological inquiry are, on the one hand, whether developing societies aspiring to accomplish an accelerated epidemiological transition can do so without the help of induced abortion; and, on the other hand, whether abortion in fact has any serious delayed sequelae such as increased prematurity, stillbirth, or psychiatric states, so that it should be used more reluctantly than ever before. Equally important are studies of unwanted and ill-timed pregnancies.

c. Epidemiology of sterility and subfecundity. If a balanced definition of family planning is to be achieved, sterility and subfecundity should be given greater emphasis in programs helping people to achieve their desired family size. Epidemiological investigation of the prevalence of sterility and subfecundity should be emphasized as providing a foundation for ultimate prevention and control of these aspects of fertility.

5. Epidemiological Assessment of Fertility Control Methods

Epidemiological methods are essential in evaluating the effectiveness and use effectiveness of fertility control

methods. To study the *relative effectiveness* of such methods under clinical trial and field trial situations as compared to the effectiveness in everyday use situations is an important epidemiological task. Another area where epidemiology can be of value is in the exploration of *relative safety* and the immediate and delayed sequelae of fertility control methods. Controversies now exist surrounding the potential vascular, carcinogenic, and psychological consequences of hormone contraceptives, and similar concerns have been arising in regard to the use of intrauterine contraceptive devices and other methods. Essential also is the careful evaluation of immediate and delayed complications of male and female sterilization, as well as of pregnancy termination and of menstrual regulation through use of such methods as prostaglandins and steroids.

Immediate epidemiological inquiry could also benefit the study of the possible interaction of fertility control methods with varying health states and therapies. In addition to further analysis of the effect of oral contraceptives on lactation, it is important to examine the interaction of these synthetic hormones with states of existing malnutrition and chronic diseases, such as tuberculosis, bilharziasis, filariasis, and diabetes and their chemotherapy. The study of relative acceptability and feasibility (both societal and individual) of specific fertility control methods under existing program conditions provides another focus for epidemiology. Such information is necessary to guide the development of new methods or the delivery system of existing methods.

6. Epidemiology of Family Planning Behavior

Methods similar to those used in the study of the epidemiology of health behavior are needed in the analysis of family planning behavior. Family planning administrators need to know, as one epidemiologist put it, "how people in fact behave or want to; as distinct from what it is believed they do, or what is considered the right thing to do or what the law says."[9]

Among the vast array of subject areas pertinent to epidemiological investigation are the following: (1) personal and cultural value systems in regard to family building; (2) the process of decision making in regard to fertility control; (3) the relationship between health behavior and family planning behavior; (4) birth control in relation to the whole area of sexuality; (5) the discrepancy between the proportion of people favoring family planning as expressed on knowledge, attitude, and practice (KAP) surveys and the proportion actually practicing birth control; (6) the pattern and causes of discontinuation of birth control methods; (7) the differential acceptability and acceptance of various birth control methods; and (8) the impact of improved health services, especially as they affect childhood survival, on acceptance of family planning programs.

Epidemiological studies of personal and group behavior in regard to family planning are fraught with difficulties, however, since family planning attitudes and behavior are surrounded, as Kessler and Kessler indicate, by "societal proscriptions on sex, and by moral and religious considerations. Contraception takes place in the highly emotional and private setting of sexuality, and the objectives and outcome of birth control methods may interfere with full satisfaction of the basic drives of procreation." They propose that epidemiologists "will want to work closely with behavioral scientists in designing studies and obtaining data on relevant aspects of personal, family and community behavior and relating the facts to health and disease."[10]

7. Epidemiology and Family Planning Programs

When family planning care is provided in the context of health services, it comes into the domain of traditional epidemiology. Whether by choice or compulsion many family planning services are provided within an existing or expanded system of health care. There is, in addition, a growing interest and practice in maternity-centered postpartum and postabortum fertility control programs. While a discussion of the pros and cons of integrating family planning care with health services is beyond the scope of this paper, it may be of interest to cite a few observations. Berelson points out that there is likely to be opposition to family planning programs if they are not integrated with health programs.[11] Rosa adds that support of the medical community is highly desirable and its participation is indispensable.[12] A comparative study in Hong Kong showed that contacts made by family planning workers in maternity homes and hospitals were twice as productive in recruiting users of fertility control as home visits by social workers.

Whether or not family planning services are provided in whole or in part within the health system, epidemiologists can provide insights into their planning, conduct surveys, and perform pilot experiments to collect data necessary for the successful operation of family planning programs. Specifically, epidemiology will be useful in:

- Carefully defining the population problem and its correlates in the local setting;
- Assessing family planning needs and resources, and the identification of gaps and imbalances as well as potentials in existing attempts to solve the problem;
- Providing better criteria by which to rank priorities and formulate realistic objectives;
- Defining and evaluating alternative strategies and program combinations for best results within existing constraints;
- Providing data for program management and optimum allocation of resources;
- Providing strategies and data for program evaluation, including efficiency and effectiveness of program components and approaches.

In the systematic study and evaluation of family planning program operations, epidemiology draws upon its experience in health services research as well as on the experience of other scientists in the use of such emerging techniques as systems analysis and operations research.

Teaching Population Epidemiology

A graduate course in population epidemiology has been developed and is included in the curriculum of the School of Public Health of the University of North Carolina each fall. The organization of the course falls into the following seven units: (1) fundamentals of epidemiology; (2) the scope of population epidemiology; (3) epidemiology of population change (the epidemiological transition); (4) the strategy of population epidemiology (research design); (5) reproductive epidemiology; (6) epidemiology and contraceptive technology; (7) epidemiology and family planning programs. Master's and doctoral degree candidates are now accepted in the specialty of population epidemiology.

As a traveling seminar, this course has also been taught in compact format for the faculty and staff of the Gandhigram Institute of Rural Health and Family Planning. The seminar was published locally in two issues of the Gandhigram *Bulletin*, which are now serving as informal texts in population epidemiology until a more comprehensive text is prepared.[13] Similar seminars have been provided or planned for Asia, Latin America, and Africa.

Rising Expectations

The discovery of new roles for their discipline requires that epidemiologists increase their preparation for and input in these new tasks as they expand their conceptual framework. The traditional approach of formulating hypotheses and testing them by empirical research may not be sufficient for the complex problems of population and family planning. The multiple causation of the problems requires multifactorial analysis and model building. Epidemiologists will have to learn not only from their own discipline and experience but from those of the social and managerial sciences as well.

In borrowing from other disciplines, epidemiologists are likely to edit, modify, transform, and rebuild techniques to suit their conceptualizations. For instance, Taylor and his associates developed a new methodology of systems analysis for a population research program in India, using selected simplified operations research tools. They called the new technique "functional analysis" because its basic concept is to relate community needs to available service resources through a functional grid.[14]

Conclusions

Population epidemiology is a new specialty which can bring to the study of one of the great problems facing mankind special descriptive, analytical, and integrative capabilities. Basic training in population epidemiology is to be recommended to those who plan to work in the field of population and family planning. Specialists in the field of population epidemiology, working in concert with other social and health scientists, can make important contributions to the understanding and solution of problems associated with population change.

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